BROOKHAVEN NATIONAL LABORATORY

Online and Offline Models

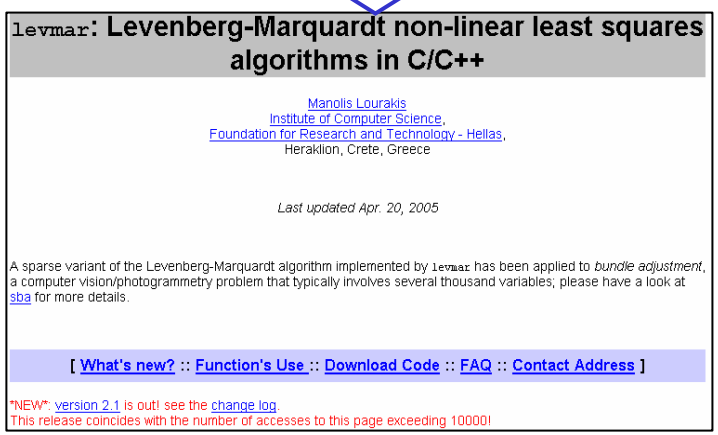
N. Malitsky

Outline

- **2004-2005 Development**
  - OptiCalc 2.x online model
  - β squeeze based on online matching
  - Online-offline interface
  - UAL-based off-line interactive analysis extension
- **New Directions**
  - Adding a closed orbit into the RHIC online model
  - Bringing the RHIC online model to the AGS environment
  - Online DEPOL
- **Summary**

OptiCalc 2.0

- Made a code more transparent by separating the physics algorithms from the CDEV client-server interface
- Added the specification of the class interfaces
- Included a matching module based on the **levmar** library with the Levenberg-Marquardt non-linear least squares algorithms (author: M. Lourakis)



levmar: Levenberg-Marquardt non-linear least squares algorithms in C/C++

Manolis Lourakis
Institute of Computer Science,
Foundation for Research and Technology - Hellas,
Heraklion, Crete, Greece

Last updated Apr. 20, 2005

A sparse variant of the Levenberg-Marquardt algorithm implemented by levmar has been applied to *bundle adjustment*, a computer vision/photogrammetry problem that typically involves several thousand variables; please have a look at sba for more details.

[What's new? :: Function's Use :: Download Code :: FAQ :: Contact Address]

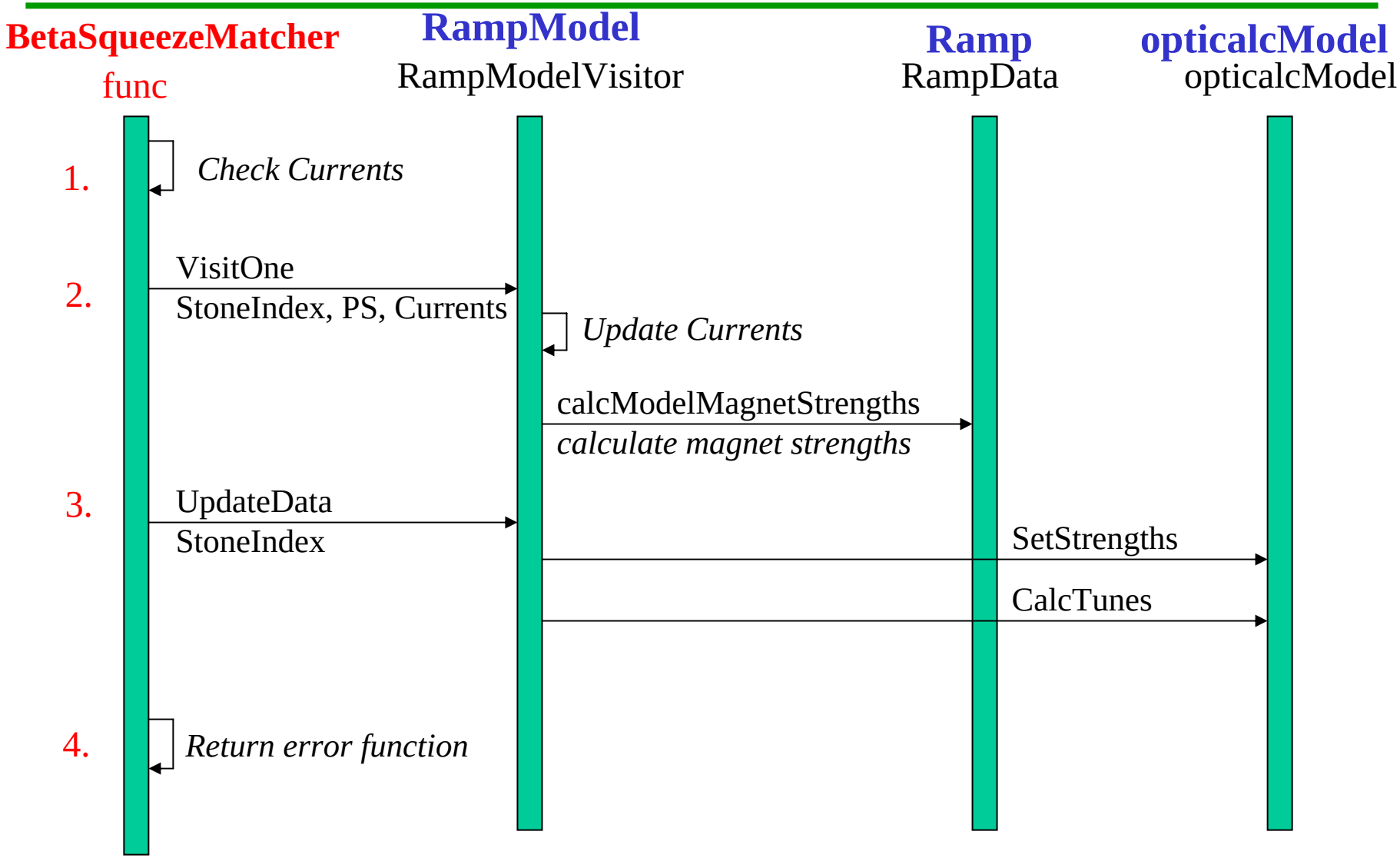
NEW: version 2.1 is out! see the change log
This release coincides with the number of accesses to this page exceeding 10000!

OptiCalc Compound List

Here are the classes, structs, unions and interfaces with brief descriptions:

OptiCalc::CdevDataTags	*CDEV Tags used in the OptiCalc CDEV-based server*
OptiCalc::CdevSystemPoller	*CDEV Online Model Poller*
OptiCalc::DataModel	*Lattice model based on opticalcModel*
OptiCalc::DataModel_CdevMonitor	*CDEV Monitor of DataModel*
OptiCalc::ElementModel_CdevMonitor	*CDEV Monitor of the element model (obsolete ?)*
OptiCalc::ElementTypes	*Collection of element types*
OptiCalc::OnlineModel_CdevServer	*CDEV Main driver for server, messages are dispatched here*
OptiCalc::RampBlue_CdevRequest	*CDEV Ramp request with "jumpTimeBlue" attribute*
OptiCalc::RampModel	*Ramp model*
OptiCalc::RampModel_CdevMonitor	*CDEV Monitor of RampModel*
OptiCalc::RampModelBase	*Basis class of RampModelVisitors*
OptiCalc::RampModelFactory	*Factory and Finder of the RampModel objects*
OptiCalc::RampModelVisitor	*Ramp Model Visitor*
OptiCalc::RampModelVisitor_CdevAdapter	*CDEV-based adapter to RampModelVisitor and RampPrimeModelVisitor*
OptiCalc::RampPrimeModelVisitor	*(Another ?) Ramp Model Visitor*
OptiCalc::RampSlope_CdevRequest	*CDEV Ramp request with the "slopefunction" attribute*
OptiCalc::RampTiming_CdevRequest	*CDEV Ramp request with the "timing" attribute*
OptiCalc::RampValue_CdevRequest	*CDEV Ramp request with the "stepstones" attribute*
OptiCalc::RampYellow_CdevRequest	*CDEV Ramp request with the "jumpTimeYellow" attribute*
OptiCalc::RingModel	*Cirular ring model, adds tunes/chrom*
OptiCalc::RingModel_CdevMonitor	*CDEV Monitor of RingModel*
OptiCalc::SpecialRamp_CdevMonitor	*CDEV special device/request(with the "name" attribute) for connecting RampModel_CdevMonitor with the RampManager corresponding device*
OptiCalc::SpecialStone_CdevMonitor	*CDEV special device/request(with the "name" attribute) for connecting StoneModel_CdevMonitor with the RampManager corresponding device*
OptiCalc::StonedK_CdevRequest	*CDEV Stepstones callback*
OptiCalc::StoneModel	*Stone Model*
OptiCalc::StoneModel_CdevMonitor	*CDEV monitor of StoneModel*
OptiCalc::StonePseudo_CdevRequest	*CDEV Stepstones callback*
OptiCalc::StoneValue_CdevRequest	*CDEV Stepstones callback*
OptiCalc::TrajModel	*Transverse line model*
OptiCalc::TrajModel_CdevMonitor	*CDEV Monitor of TrajModel*

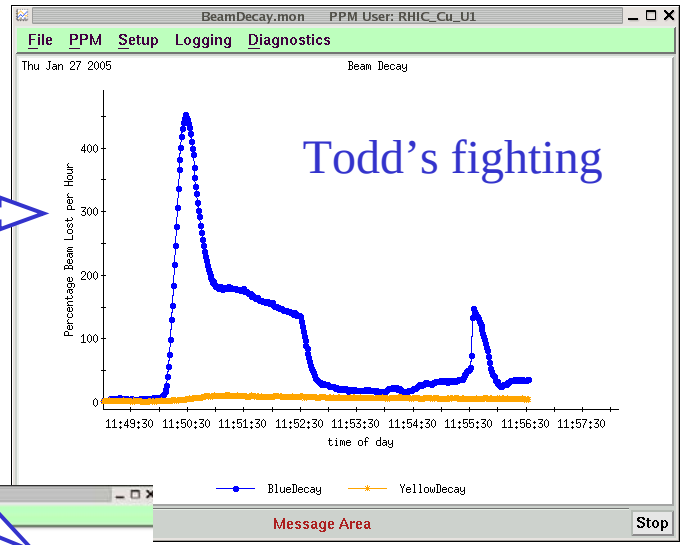
Interaction diagram of the Beta Squeeze Matcher function called in the optimization iterations

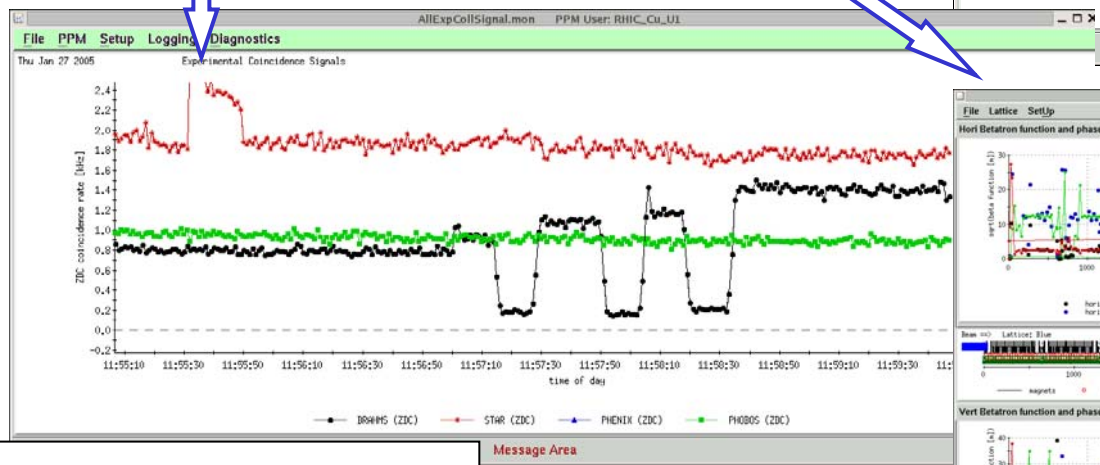


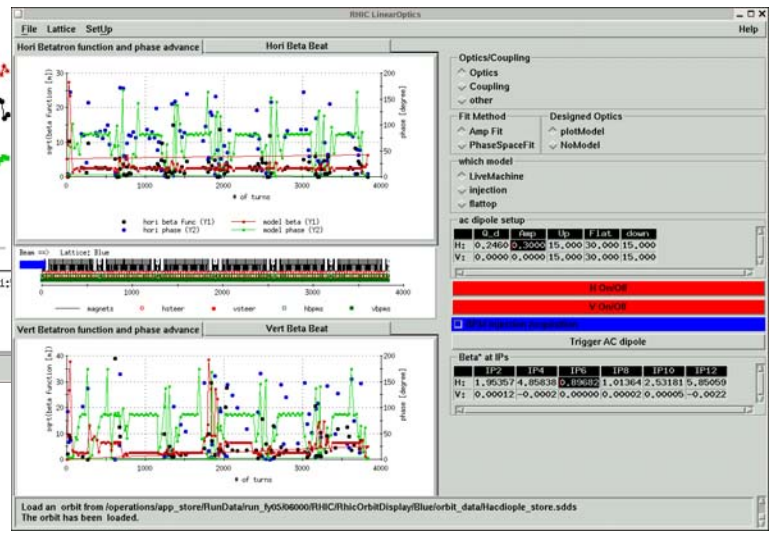
Online Beta Squeeze Beam Experiment

M.Bai, N.Malitsky, F.Pilat T.Satogata, S.Tepikian

- Calculate and setup the store stone quads for the new IR2 β*
- Ramp 6 bunches in both rings
- Squeeze IR2 β* from 3 to 2 m (with slow factor 15)
- Measure rates
- Measure optics



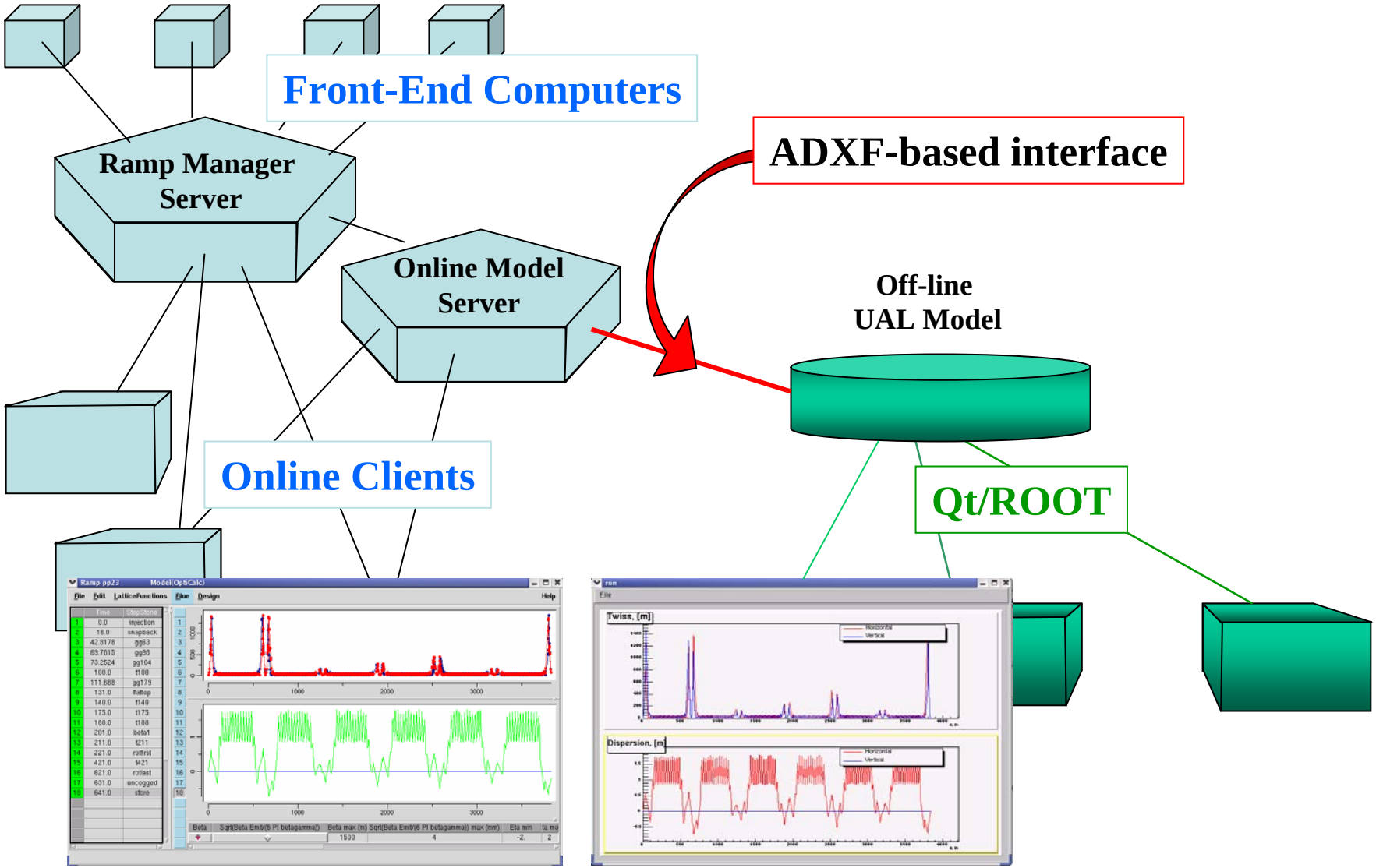




Ramp 5999, 6 bunches

RHIC Joined Online and Off-line modeling environment

PAC 2005



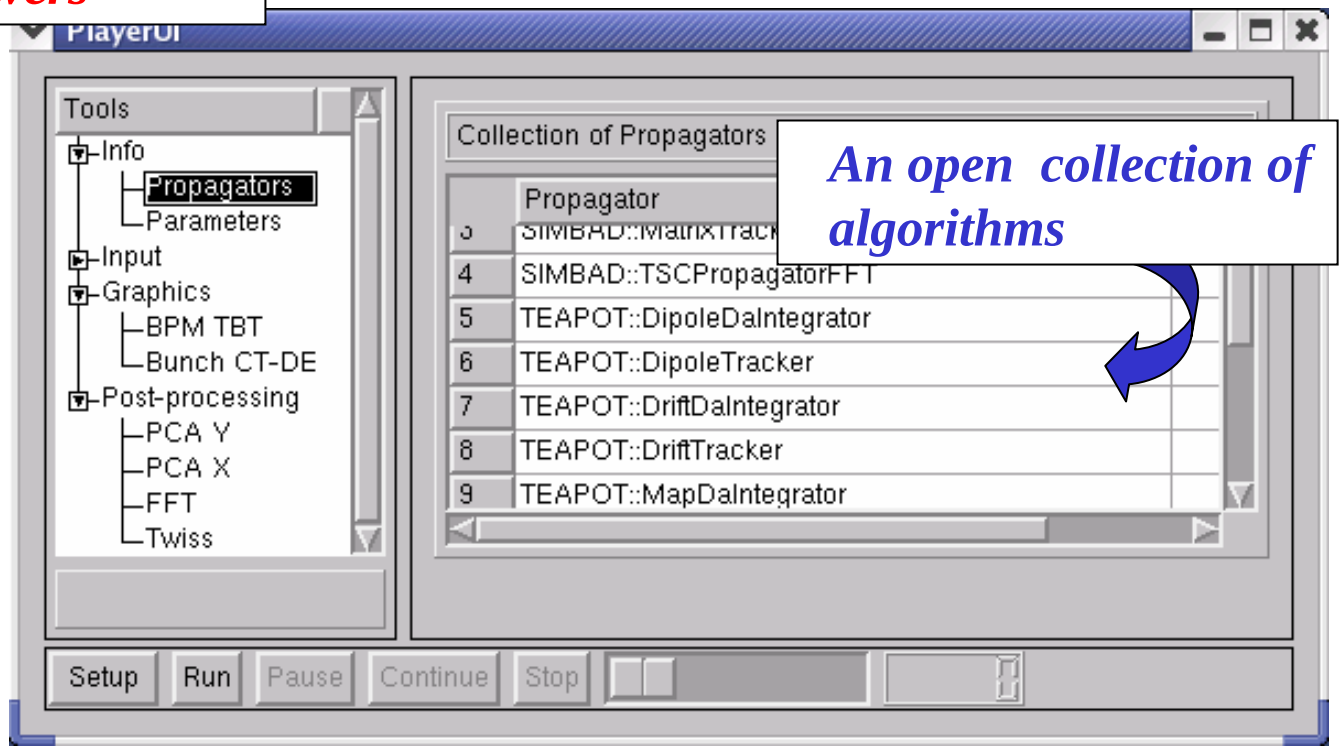
UAL-based Accelerator Physics Player

V.Fine, N.Malitsky, R.Talman. ACAT 2005

Objectives:

- Bring the UAL off-line applications to the RHIC online environment for analyzing accelerator physics experiments and operational data.
- Facilitate modeling and analysis of multi-particle applications, such as beam-beam and space charge effects, instabilities, cooling, *etc*.)

An open collection of viewers



An open collection of algorithms

New Directions

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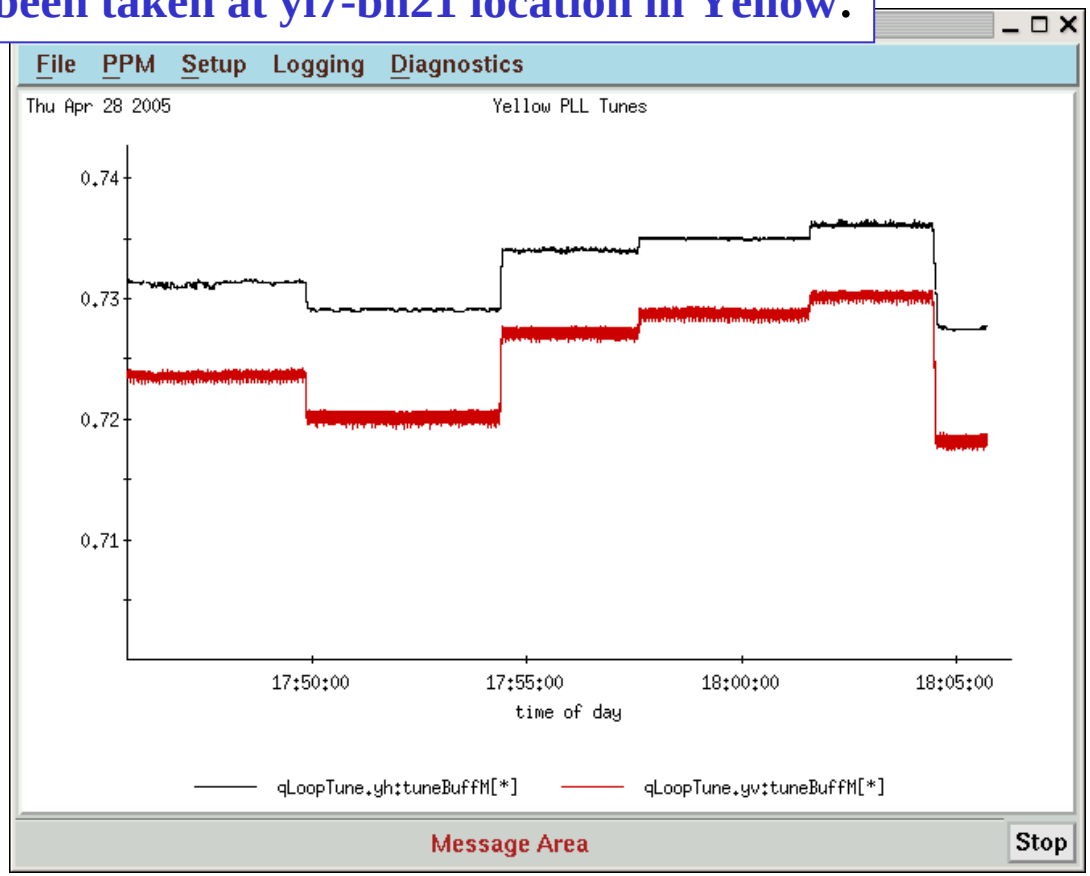
Tune shift versus orbit bump

V.Ptitsyn

Data have been taken at yi7-bh21 location in Yellow.



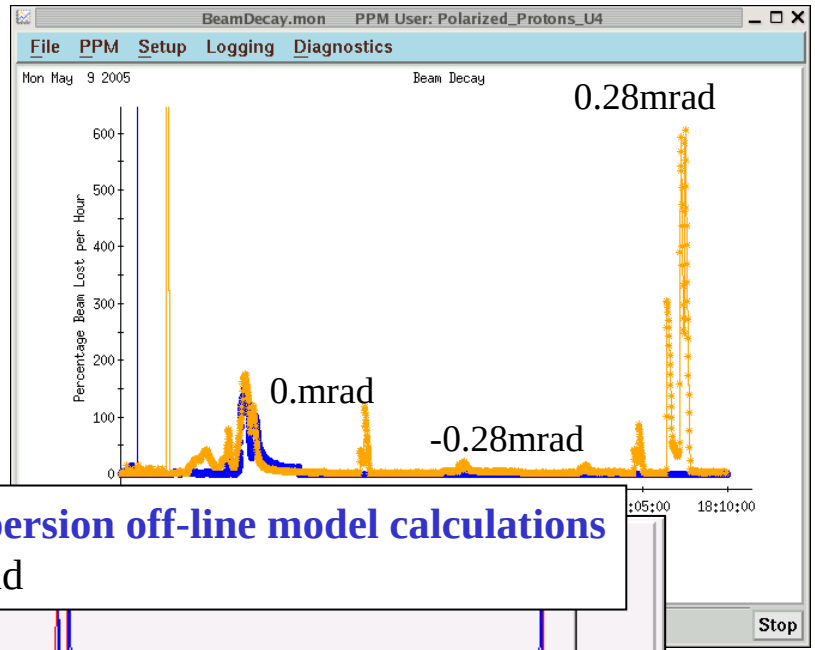
Effect of orbit bumps on momentum aperture

M. Bai, V.Ptitsyn, et al.

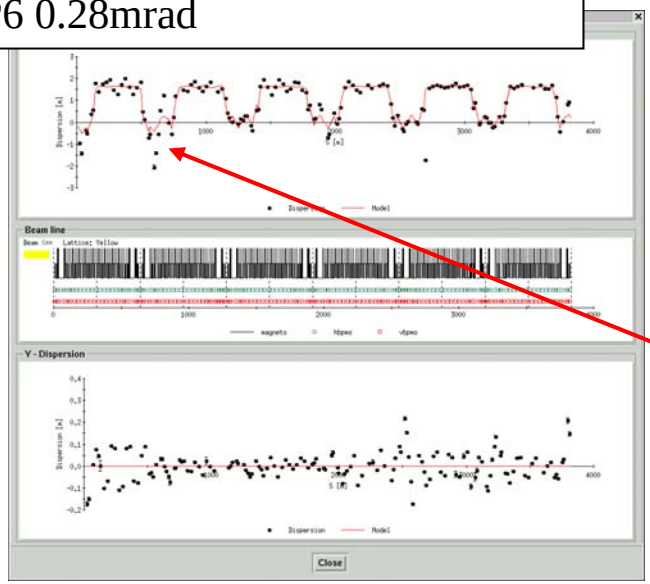
• Momentum aperture and dispersion functions depend on orbit changes and strongly asymmetric relative to the orbit angle bumps in IR6 and IR8.

• Should the orbit correction and IR steering at the store take into account and compensate dispersion function changes?

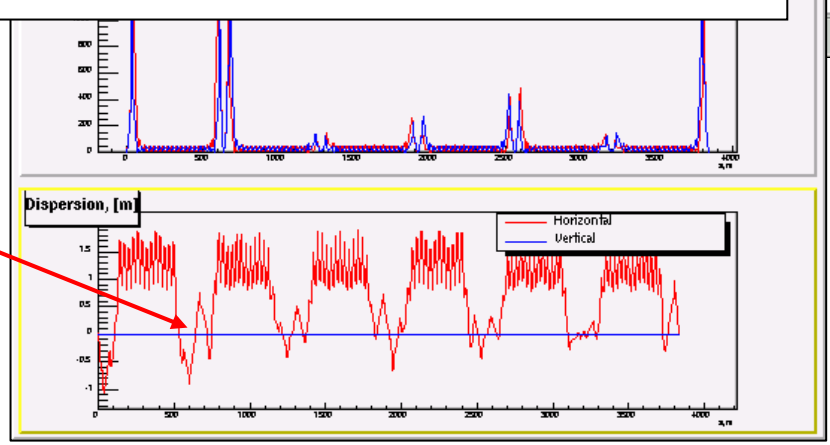
Yellow beam decays from orbit angle in IP6



Yellow dispersion measurements
IP6 0.28mrad



Yellow dispersion off-line model calculations
IP6 0.23mrad



Adding a closed orbit into the RHIC online model

N.Malitsky, J.Kewisch, et.al

Magnetic Field:

In ADXF, as in most lattice descriptions, magnetic field deviations are expressed as *multipole series*. For a bending magnet the magnetic field, as well as the effect of transverse positioning deviations $(\Delta x, \Delta y)$, are expressed as a (complex) series:

$$(B_y + iB_x)l_m = B_0 l_m \sum_{n=0}^{M} (b_n + ia_n)\big((x - \Delta x) + i(y - \Delta y)\big)^n. \qquad (8.13)$$

Off-line UAL/TEAPOT model enjoys the **automatic differentiation approach** based on Differential Algebra:

Coordinate could be double or TPS (Truncated Power Series)

Coordinate x, y

```
 x = p[0]; //  xdif
 y = p[2]; //  ydif
if(offset) {
   x -= offset->dx();
   y -= offset->dy();
}
```

ZLIB::VTps : size = 6 (dimension = 6 order = 2)

closed orbit

0	1.3012167032873e-18	2.2290537236164e-20	...	0	0	0	0	0	0
1	1.5658620810311e-01	-2.9573156020218e-01	…	1	0	0	0	0	0
2	3.2985345181454e+00	1.5658620810311e-01	…	0	1	0	0	0	0

Online OptiCalc equations have to be explicitly extended

Adding a closed orbit (or other effects) into the RHIC online model

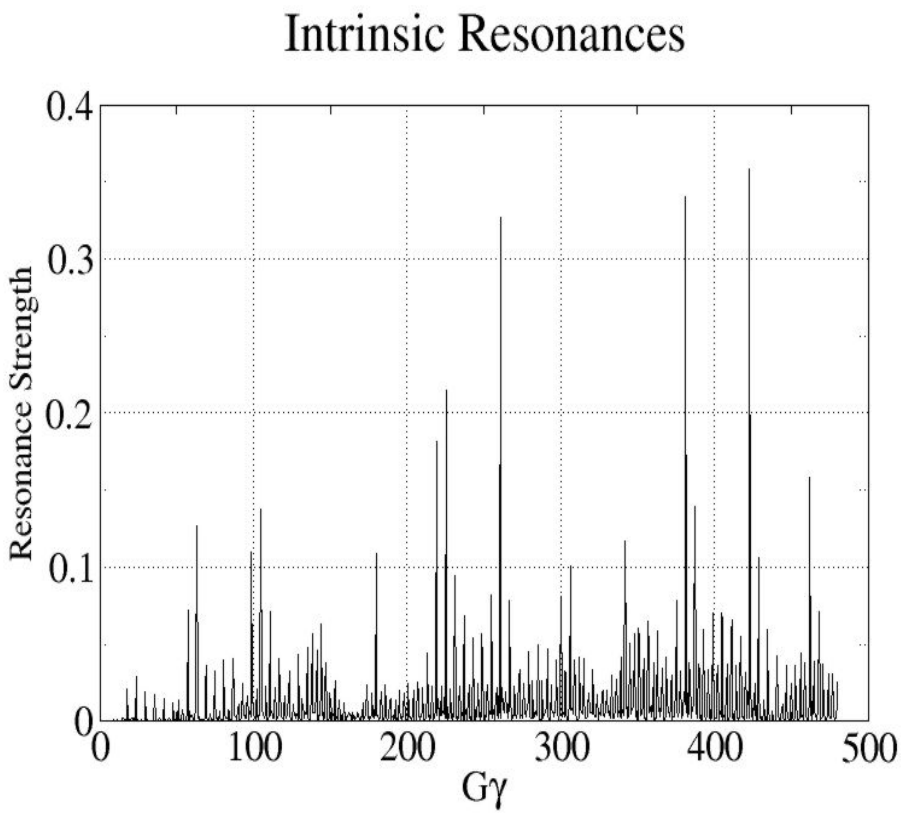
Comments:

- **F. Pilat**: add/reproduce a measured orbit
- **T.Satogata**: coupling (global and local)
- **D.Trbojevic:** orbit-coupling-multipoles development pattern

Online Depol

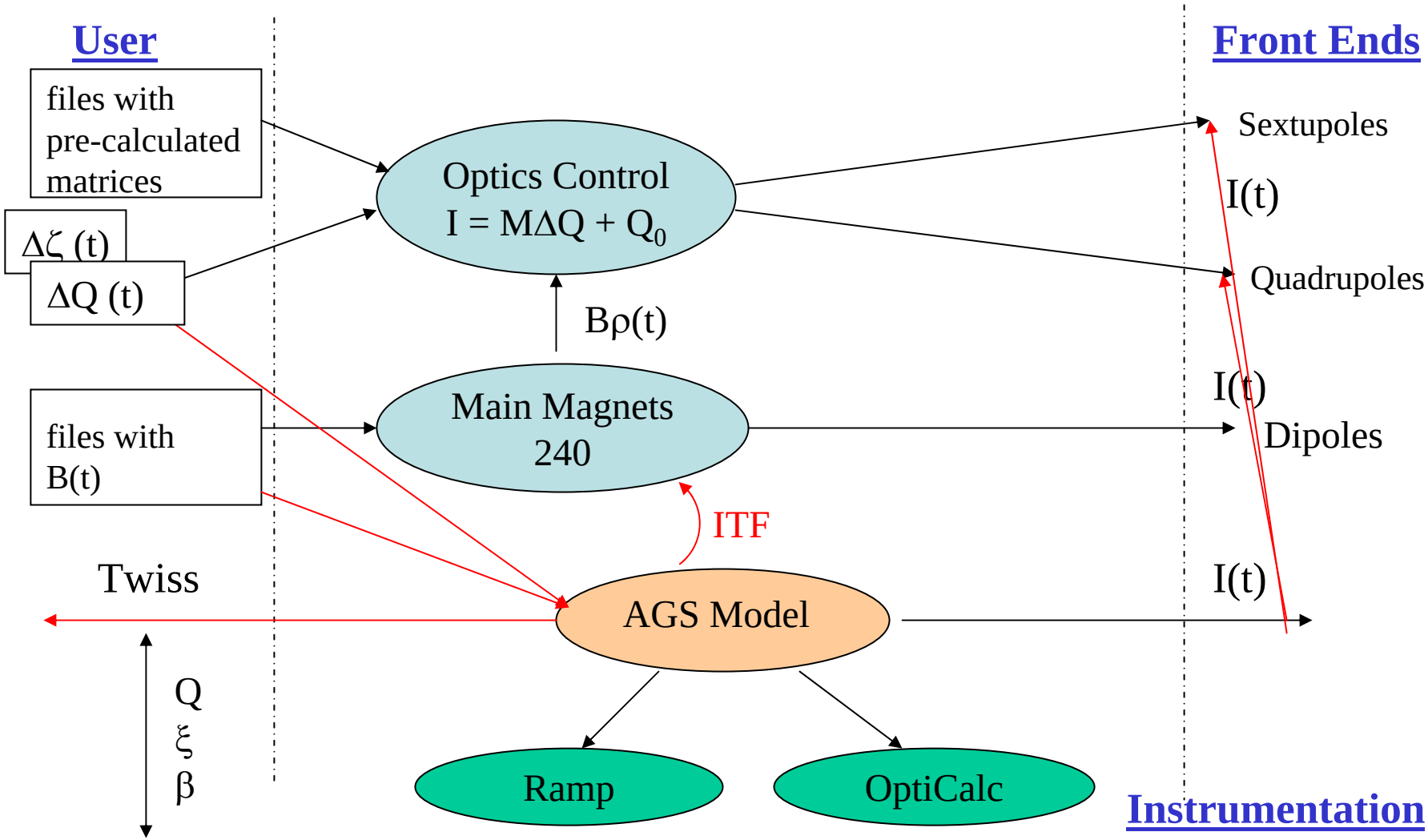
V. Ptitsyn, S.Tepikian

- Depolarizing resonances
  - $G\gamma_0 = k$ (imperfection)
  - $G\gamma_0 = k \pm Q_y$ (intrinsic)
- Add **Depol** to OptiCalc (E. Courant, R. Ruth, V. Ranjabar, ...)
  - Depends on optics (squeeze)
  - Measured orbit errors.
- Future possibilities...
  - Measured emittance (IPMs)
  - Measured tunes.
  - Coupling



AGS Online Modeling Environment

K. Brown, L. Ahrens, et al.



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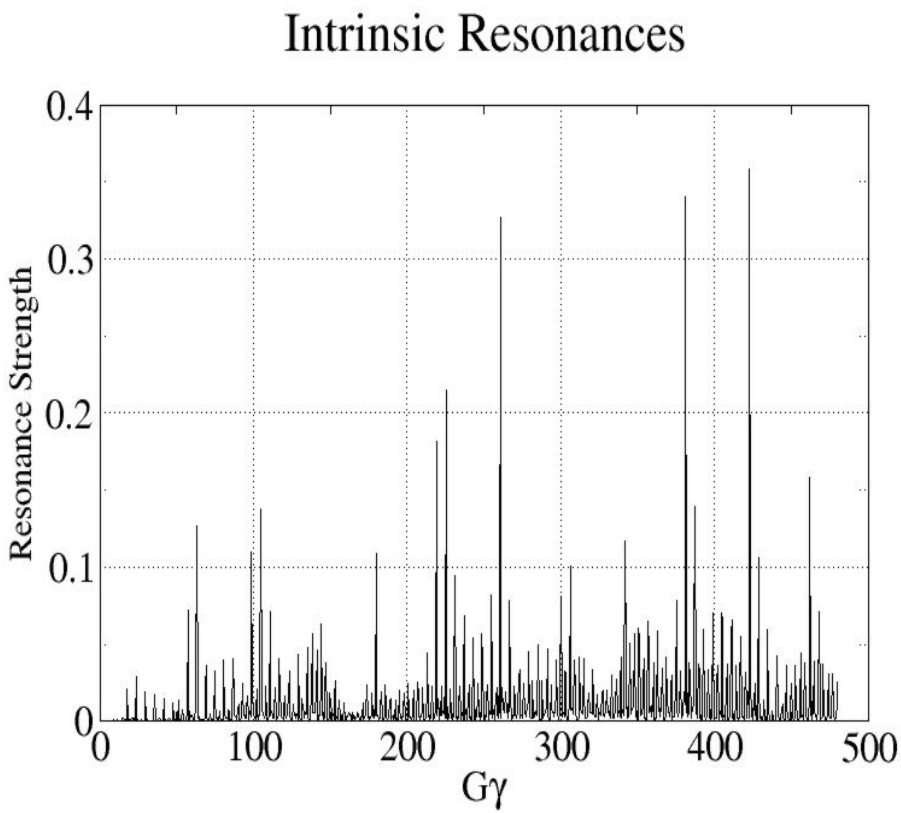

Summary

- **RHIC online and off-line models have been consolidated**
- **They form a basis for new developments and extensions:**
  - adding an orbit and orbit-based algorithms (e.g. DEPOL) into the online model.
  - bringing the RHIC online (OptiCalc/Ramp) and off-line (UAL/SIMBAD) models to AGS